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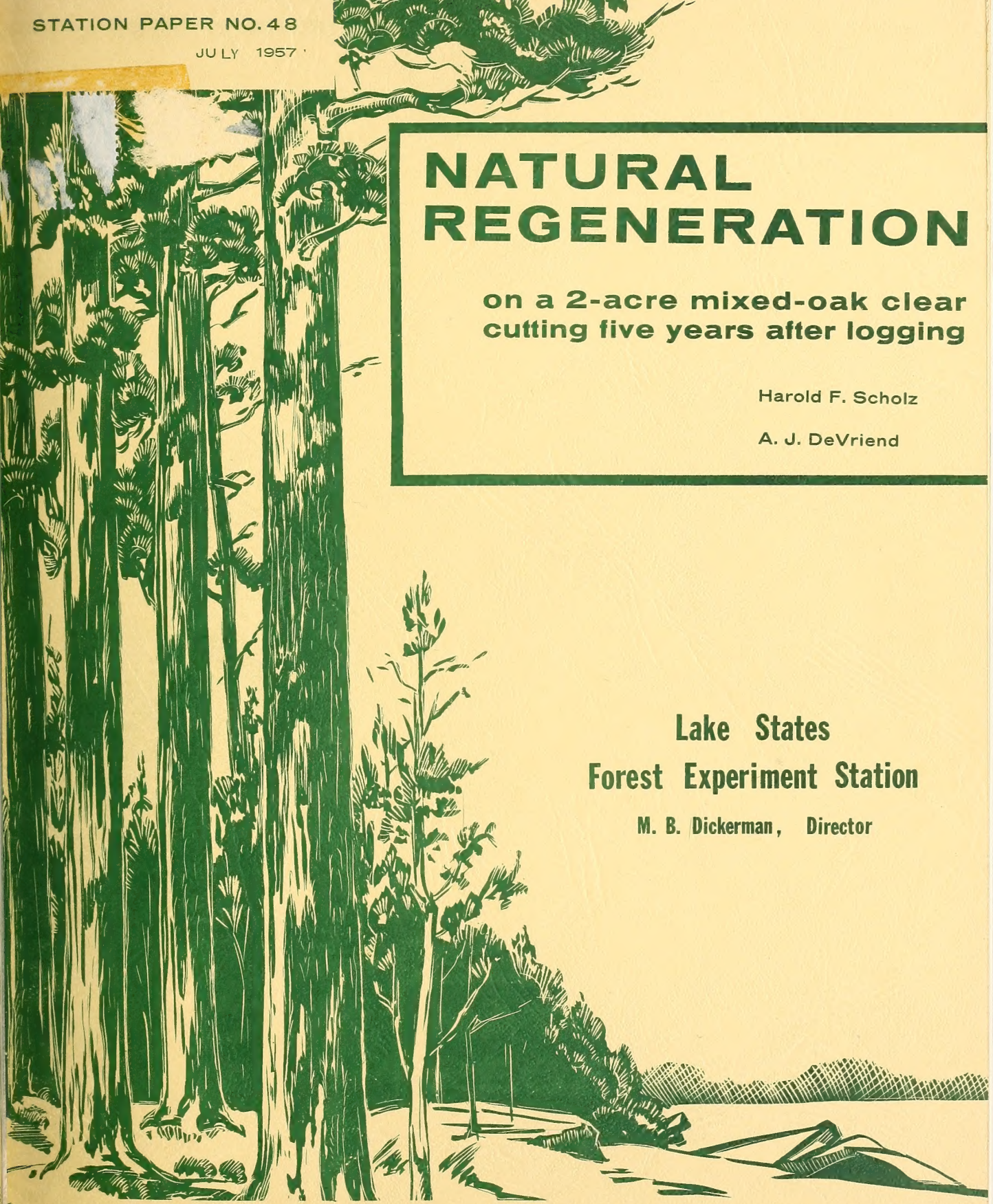

Lake States
Forest Experiment Station
M. B. Dickerman, Director

U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
ST. PAUL, MINNESOTA

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FIVE YEARS AFTER LOGGING

by

Harold F. Scholz[1/] and A. J. DeVriend[2/]

Oak is an Important Forest Type in the Lake States Region

In 1953, the oak-hickory forests of the Lake States region occupied an estimated 6,443,000 acres.[3/] Forty-eight percent of this acreage was in Wisconsin, 30 percent in Michigan, and 22 percent in Minnesota. The net volume of northern red oak and white oak sawtimber on these forested lands, plus that accounted for by scattered trees of the same two species in other hardwood types, was placed recently at 7.56 billion board-feet.[4/] Of this total, 74 percent was comprised of northern red oak (Quercus rubra L.) and 26 percent white oak (Q. alba L.). With the possible exception of sugar maple (Acer saccharum Marsh.), northern red oak accounts for a greater proportion of the total net sawtimber volume of all Lake States hardwoods than any other tree.

The mixed-oak woodlands of the Lake States Region are characteristically even-aged, moderately fast growing, and of good tree form. Gross yields of 10 thousand to 17 thousand board-feet per acre are not uncommon in fully stocked stands at 80 years of age on the better sites.[5/]

1/ Research Forester, Lake States Forest Experiment Station. The Station is maintained at St. Paul 1, Minn., by the Forest Service, U. S. Department of Agriculture, in cooperation with the University of Minnesota.

2/ Field Supervisor, Wisconsin Conservation Department.

3/ Cunningham, R. N. and Survey Staff. 1956. Lake States timber resources. U. S. Forest Serv., Lake States Forest Expt. Sta., Sta. Paper 37, 31 pp. (Processed.)

4/ Burks, George F. 1955. Summary of basic statistics. In Timber Resource Review, Chapt. IX, App. A., Table 7, Forest Serv., U. S. Dept. Agr. (Prelim. Review Draft.) (Processed.)

5/ Gevorkiantz, S. R., and Scholz, Harold F. 1948. Timber yields and possible returns from the mixed-oak farmwoods of southwestern Wisconsin. Wis. Dept. Conserv. Publ. 521, 72 pp., illus.

But Much Must Be Learned About Its Silvicultural Management

In spite of the importance of the oak type, there is a dearth of information concerning the effect of various cutting practices and supplementary cultural measures on oak regeneration. The tendency for sugar maple, American elm (Ulmus americana L.), American basswood (Tilia americana L.), and other light-seeded, and often less valuable, tree species to invade the mixed-oak forests is a matter of concern to foresters and landowners alike. How to prevent this natural conversion or, of greater importance, how to insure a constant and adequate supply of northern red oak seedlings for restocking the stand is the primary problem in oak management.

Some Preliminary Research Studies Have Been Initiated

For lack of accepted guides, trial-and-error silvicultural methods have been used in harvesting and attempting to regenerate oak woodlands in the three Lake States. On the assumption that selection cuttings are not applicable to stands which are typically even-aged, usually some modification of the shelterwood system has been employed. In the majority of cases, the sawtimber is removed in three stages. The first of these takes out 20 to 30 percent of the total basal area of fully stocked, merchantable forests and is confined to removing suppressed and intermediate stems.

Five to ten years later, the exact period depending upon the progress of natural reproduction, a second cut is made which reduces the main stand to about one-third of its original basal area and leaves scattered, but well-distributed, codominant and dominant seed trees. These, in turn, are harvested by a third and final cutting when adequate natural regeneration of northern red oak has become established and its survival seems assured.

Experiments involving the shelterwood concept now are in the fifth year of observation on the Hardies Creek Timber Harvest Forest near Galesville (Trempealeau Co.), Wis., and similar projects are being planned for other areas in the State.

While clear cutting rarely has been recommended for managing oak in the Lake States Region, there is a definite need for exploring the ecological changes that occur when the overstory in such stands is completely removed and these areas subsequently are protected from livestock and fire. Observations of this character have been made on the Dundee

Timber Harvest Forest[6/] in eastern Wisconsin during the past 5 years. The study is described below.

A Case History of an Oak Clear Cutting

The study area is a well-stocked oak woods in which the trees on about 2 acres were seriously weakened by a hot ground fire in 1945. A few dead and dying trees were salvaged in 1946, but the unit was not clear cut until the early winter of 1949 after an exceptionally heavy crop of acorns and other tree seed had matured and fallen to the ground. Observations were begun in October 1951 on a 1-acre plot established to follow the progress of natural restocking by forest tree species. This small block was delineated and marked with permanent corner stakes in May 1950, but logging and fuelwood cuttings, plus piling and burning of slash, denuded the area so completely (fig. 1) that the first regeneration counts were delayed until the vegetation had gone through a 2-year recovery period. The second examination was made in May 1955, three growing seasons later.

6/ Located in Fond du Lac County, just off State Highway 67, about $1\frac{1}{2}$ miles west of the village of Dundee or $5\frac{1}{2}$ miles east-northeast of Campbellsport. Owned by the Wisconsin Conservation Department and maintained cooperatively by the State and U. S. Forest Service.

Figure 1.--The degree to which the Dundee Timber Harvest Forest clear cutting reduced the site to bare-ground conditions is evident from this photograph taken on the study area in May 1950.

That there was an adequate timber stand to furnish seed prior to and immediately after the hot ground fire of 1945 is shown by records from five permanent sample plots situated on or near the study area. When established in 1947, they had an average stocking of 142 stems per acre 3 inches in diameter at breast height and larger and a total basal area of 121.7 square feet (table 1). The sawtimber overstory had a mean diameter of 14.7 inches d.b.h. and accounted for 66 percent of all trees and 91 percent of all basal area. These stems were about 90 years old and contained an estimated net volume of 9,751 board-feet per acre, Scribner log scale. Northern red oak was the dominant species. Other associates included white ash (Fraxinus americana L.), American basswood, sugar maple, American elm, white oak, red maple (Acer rubrum) L.), shagbark hickory (Carya ovata (Mill.) K. Koch), paper birch (Betula papyrifera Marsh.), and eastern hophornbeam (ironwood) (Ostrya virginiana (Mill.) K. Koch).

Tree seedlings of all species totaled 10,480 stems per acre at the time of the first counts and 7,080 per acre 4 years later (table 2). It is recognized that some of these small hardwoods may be of seedling-sprout origin. However, on the basis of the current stocking of seedlings in adjacent uncut woodlands, reproduction that originated in this way is believed to be of secondary importance on the 2-acre clear cutting. Unfortunately, a pre-logging seedling tally, which would have been helpful in clarifying this point, was not made.

In 1951, northern red oak comprised 37.5 percent of the total hardwood regeneration exclusive of sprouts, whereas it amounted to only 17.2 percent in 1955. The fact that the mortality of this species was much higher than for the group classed as "other hardwoods" appears to give substance to the theory that light-seeded trees tend to supplant oak in the first rotation following a clear cutting. Severe competition from woody shrubs of the genus Rubus (Tourn.) L.--blackberry and raspberry--and associated herbaceous plants was particularly lethal to northern red oak seedlings (table 3).

Several stand-composition changes have occurred since logging in 1949. Of first importance is the 69 percent reduction in the number of northern red oak seedlings which took place during the last three growing seasons.

Another significant development is the increase of low-value, off-site, or otherwise inferior species (eastern hophornbeam, paper birch, aspen, red maple, white oak, shagbark hickory, and black cherry) in the regeneration as compared to the composition of the parent stand. Collectively, the less desirable trees amounted to only 20 percent of the total number of pole and sawtimber stems in the original stand, but they comprised about 36 percent of the seedlings on the clear cutting in 1955 (table 4). In contrast, the top-quality species (northern red oak, American basswood, and white ash) which accounted for 65 percent of the merchantable stems in 1947, amount to only 29 percent of the current non-coppice reproduction.

Table 1.--Character of the mixed-oak stand on the Dundee study area in 1947[1/]

Species	Trees per acre			Basal area per acre			Net sawtimber volume per acre
	Sawtimber[2/]	Saplings & poles[2/]	Total	Sawtimber[2/]	Saplings & poles[2/]	Total	
	Number	Number	Number	Sq. ft.	Sq. ft.	Sq.ft.	Bd.-ft. (Scribner)
Northern red oak	82	5	87	101.5	2.0	103.5	9,170
White ash	3	-	3	2.4	-	2.4	173
Basswood	2	-	2	2.7	-	2.7	166
Sugar maple	2	18	20	1.3	2.6	3.9	74
Shagbark hickory	1	10	11	.7	2.6	3.3	37
White oak	2	8	10	1.3	2.2	3.5	65
Red maple	1	-	1	.6	-	.6	31
Paper birch	1	-	1	.7	-	.7	35
American elm	-	2	2	-	.7	.7	-
Eastern hophornbeam	-	5	5	-	.4	.4	-
Total	94	48	142	111.2	10.5	121.7	9,751

1/ Based on data from five permanent sample plots.

2/ Sawtimber includes all stems 9.6 inches d.b.h. and larger, while saplings and poles are trees 2.6 to 9.5 inches d.b.h.

Table 2.--Number and distribution of tree seedlings on a mixed-oak clear cutting in the second and fifth years after logging

Total height of seedlings (feet)	Number of seedlings per acre[1/]					
	Northern red oak		Other hardwoods[2/]		All species	
	1951	1955	1951	1955	1951	1955
Less than 0.5	1,050	30	800	380	1,850	410
0.5 to 4.5	2,880	1,010	4,520	2,980	7,400	3,990
4.5 to 9.5	0	180	1,210	1,830	1,210	2,010
More than 9.5	0	0	20	670	20	670
Total	3,930	1,220	6,550	5,860	10,480	7,080

1/ Based on an identical 100-milacre sample in both years.

2/ Percentage distribution of other hardwoods in 1951 and 1955 respectively was: American elm, 40.5 and 35.2; sugar and red maples, 22.4 and 7.8; black cherry (Prunus serotina Ehrh.), 13.7 and 29.3; white ash and basswood, 9.8 and 14.0; and paper birch, ironwood, and aspen (Populus tremuloides Michx.), 13.6 and 13.7.

Table 3.--Stocking of northern red oak and other hardwood seedlings as affected by competition from woody shrubs and herbaceous plants

Competition	Species	No. of seedlings per acre		Change in percent
		1951	1955	
Light-to-medium[1/]	Northern red oak	5,000	3,190	-36.2
	Other hardwoods[2/]	5,286	7,667	+45.0
	Total	10,286	10,857	+ 5.6
Severe[3/]	Northern red oak	3,646	696	-80.9
	Other hardwoods	6,887	5,381	-21.9
	Total	10,533	6,077	-42.3
Both classes	Northern red oak	3,930	1,220	-69.0
	Other hardwoods	6,550	5,860	-10.5
	Total	10,480	7,080	-32.4

1/ This condition occurred on 21 milacres.

2/ American elm, white ash, American basswood, black cherry, sugar maple, red maple, paper birch, aspen, and eastern hophornbeam.

3/ This condition occurred on 79 milacres.

Table 4.--Composition of the original mixed-oak stand as compared to that of the subsequent regeneration

Species	Relative commercial importance on this site	Percent of total stems		
		Original stand (142 stems)	Seedling regeneration	
			In 1951 (10,480 stems)	In 1955 (7,080 stems)
Northern red oak	High	61.3	37.5	17.2
White ash		2.1	4.6	7.8
Basswood		1.4	1.5	3.8
Total		64.8	43.6	28.8
Sugar maple	Medium	14.1	12.2	6.5
Elm[1/]		1.4	25.3	29.1
Total		15.5	37.5	35.6
Black cherry	Low	0	8.6	24.3
Eastern hophornbeam		3.5	8.0	9.7
Red maple		.7	1.8	0
Paper birch		.7	.5	1.4
Shagbark hickory		7.8	0	0
White oak		7.0	0	0
Aspen		0	0	.2
Total		19.7	18.9	35.6
All species		100.0	100.0	100.0

1/ Principally American elm, but also includes some slippery elm (*Ulmus rubra* Mühl.).

On the more encouraging side is the fact that about 83 percent of all regeneration has been of seedling origin (table 5 on next page). The excellent growth made by northern red oak seedlings also is gratifying. Most of these trees were only 6 to 8 inches tall in 1951, but by the spring of 1955, 40 of them taken at random averaged 35.9 inches in height. There is good evidence that a substantial percentage of this oak regeneration eventually will outstrip the competing woody shrubs (fig. 2). Moreover, the 1,220 red oak seedlings remaining per acre in 1955 probably constitute an acceptable stocking considering that the stand had just 82 sawtimber trees per acre when it was cut in 1949 (see table 1).

On the basis of the 100-milacre sample tally used for this study, the distribution of these northern red oak seedlings also appears satisfactory, with 46 stocked milacres as compared to 54 with no red oak. However, these latter quadrats supported tree seedlings of other species in 74 percent of all cases, and these additional 5,860 stems per acre will contribute substantially to the density of the future stand.

Figure 2.--The northern red oak seedling in the middle foreground already has asserted enough dominance to compete on even terms with other trees and woody shrubs around it. Note the improvement in vegetative conditions over that of 1950.

Table 5.--Comparison of the number of hardwood seedlings and sprouts on the Dundee clear cut study area in 1951 and 1955

Species	Reproduction stand: No. per acre			
	In 1951		In 1955	
	Seedlings	Sprouts	Seedlings	Sprouts
Northern red oak	3,930	1,470	1,220	590
White ash	480	0	550	0
Basswood	160	0	270	190
Sugar maple	1,280	770	460	400
Elm	2,650	0	2,060	50
Black cherry	900	0	1,720	180
Eastern hophornbeam	840	0	690	10
Red maple	190	0	0	0
Paper birch	50	0	100	0
Shagbark hickory	0	30	0	0
White oak	0	0	0	0
Aspen	0	0	10	0
Total	10,480	2,270	7,080	1,420

Significance of Observations

This study indicates that removal of the overstory in one cutting may have applicability under certain conditions for reproducing oak in Wisconsin. However it must be remembered that this cutting covered only 2 acres, that the area was surrounded on three sides by a mature stand, and that immediately before the cutting a heavy crop of seed was produced. Therefore the results are presented here solely as an aid to further understanding of the oak regeneration problem.

Before a full evaluation can be made of clear cutting as a silvicultural system for oak, a great deal more information will be required. Data are needed on such factors as frequency of heavy crops of acorns, radius of seed-dispersion, seedbed requirements, germinative capacity of the seed, and the extent to which seedlings are inhibited, damaged, or destroyed by animals, insects, diseases, or competing woody and herbaceous plants. What percentage of the total post-logging seedling restocking is of pre-logging origin also should be determined, for upon this point will hinge the decision on whether the advanced reproduction should be favored or ignored during harvesting operations in the valuable oak forests of the Upper Mississippi Valley region.

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